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SELECTED PAPERS FROM
ICOM'01, ICOM'05 AND
ICOM'08

Editors

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Selection of Materials and Design Specification for Hip Joint Prosthesis

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ABSTRACT

The hip is essentially a ball and socket joint, linking the "ball" at the head of the thigh bone (femur) with the cup-shaped "socket" in the pelvic bone. A total hip prosthesis is surgically implanted to replace the damaged bone within the hip joint. Basically, the hip joint prosthesis consists of three parts: (1) acetabular cup that replaces hip socket, (2) a metal or ceramic ball that will replace the fractured head of the femur and (3) a metal stem that is attached to the shaft of the bone to add stability to the prosthesis. Parameters determining the performance of the total hip joint replacement are materials, design, and fixation method. The materials used in a hip replacement are designed to enable the mechanical joint to move just like a normal joint. The prosthesis is composed of several types of metal and durable plastic. One of the inherent problems in hip joint prosthesis implantation is the fixation and maintenance of a stable interface between the device and the host tissue at the cellular and organ levels. Although evaluation of success or failure of the prosthesis fixation could be quite difficult clinically, proper material design will minimize potential problems probably appearing after implantation. Recent progress on materials design and development for this application will be presented.

1. INTRODUCTION

1.1. Human Bones and Hip Joints

Bones are calcified connective tissue forming the major portion of the skeleton of most vertebrates. They contain more calcium than any other organ. Bone is composed of inorganic and organic materials in dynamic equilibrium with the body fluids. Although the proportions vary from one part of the skeleton to another, water-free bone contains about 70% inorganic and 30% organic materials. The inorganic phase consists of calcium phosphate-based ceramics, primarily hydroxyapatite crystals; it is hard and brittle and represents the main load-bearing component of the bone structure. The organic phase, primarily collagen fibers, is gelatine-like protein and its presence makes the bone tough, in addition to its biological functions [1]. These phases are generally arranged in a complex structure to give maximum strength in the required direction.

When two or more bones meet each other they form joints. Joints make the skeleton flexible. Without them, movement would be impossible. The human hip joint consists of a ball (*femoral head*) at the top of our thighbone (*femur*) that fits into a rounded socket (*acetabulum*) in our pelvis. Typical construction of the ball and the socket allows for movement in almost all directions. A simple illustration of the human hip joint is presented in Figure 1. The femur is the bone of the upper leg,